DESIGN AND ANALYSIS OF A MULTIVARIATE REGRESSION MODEL USING ARTIFICIAL NEURAL NETWORK

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This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Robotics & Automation) (Hons.)

by

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2014

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: **Design and Analysis of a Multivariate Regression Model Using Artifical Neural Network**

SESI PENGAJIAN: **2013/14 Semester 2**

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APPROVAL

This report is submitted to Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Robotics & Automation) (Hons.). The member of the supervisor committee is as follow:

…….

(Engr. Dr.-Ing Azrul Azwan Bin Abdul Rahman)

ABSTRAK

Rangkaian neural menyediakan satu aplikasi yang boleh digunakan dalam pelbagai bidang secara luas. Ia adalah teknik baik yang baru untuk menyelesaikan masalah dalam pelbagai sistem yang kompleks. Tujuan kajian ini adalah untuk membangunkan satu model rangkaian neural buatan berdasarkan model regresi. Dalam sistem yang kompleks pengunaan pengiraan matematik seperti kaedah regresi boleh menyebabkan beberapa masalah berlaku dan ketepatan sistem ini tidak dapat disimpulkan. Untuk mengkaji prestasi rangkaian neural, satu eksperimen direka. Proses mesin pengisaran berkelajuan tinggi, dipilih bagi menjalankan ujikaji menggunakan kaedah Box Behken. 29 sampel digunakan dengan menggunakan pembolehubah parameter seperti kelajuan pemotongan, kadar suapan dan kedalaman pemotongan. Data kekasaran permukaan diperoleh, dikumpul untuk digunakan dalam menganalisa model rangkaian neural dan regresi. Model regresi menggunakan daripada manakala rangkaian neural menggunakan algoritma kabur rangkaian kognitif dengan mengunakan peraturan pembelajaran pembezaan hebbian dan fungsi pengaktifan linear. Model matematik yang dibangunkan menggunakan kaedah regresi berganda menunjukkan ketepatan 96,637 % , manakala sebagai untuk model yang dibangunkan menggunakan pameran rangkaian neural ketepatan 99.999976% dan 99.9999596% untuk latihan dan ujian peringkat masing-masing, dalam meramalkan kekasaran permukaan. Ini menunjukkan kebolehlaksanaa

dalam rangkaian neural untuk membandingkan kepada regresi berganda. Keputusan ini adalah sebagai panduan untuk kajian masa depan atau untuk pelaksanaan dalam sistem yang kompleks.

ABSTRACT

Neural network provide an application that can be applied in a broad range. It is a great new technique for solving problems in many different disciplines. The purposed of this study is to develop a model of artificial neural network based on a model of regression. In a complex system, using hard computational such as regression method could cause several problems to occur and the accuracy of the system cannot be inferred. In order to study the performance of neural network, an experiment is designed. High speed end milling is one of the manufacturing processes that are selected for the experiment conducted based on the design of experiments using Box-Behken method. 29 samples were conducted using variables parameters such as cutting speed, feed rate and depth of cut. The data of surface roughness obtain are collected to be used in analyzing the model of neural network and multiple regression. Regression model using the second-order form while neural network using fuzzy cognitive network algorithm with differential hebbian learning rules and linear activation function. The mathematical model developed using multiple regression method demonstrate the accuracy of 96.637%, while as for the model developed using neural network exhibit an accuracy of 99.999976% and 99.9999596% for training and testing stage respectively, in predicted of the surface roughness. This shows the feasibility and applicable of neural network

compare to multiple regressions. This result is as a guide for future research or implement on the complex system.

DEDICATION

All praise to HIM for make this to reality

To my beloved parents for their endless support

To my lecturers for their knowledge given to me

To myself for not easily giving up when facing difficulties

To my love of my life for always being an understand on my situation

ACKNOWLEGDEMENT

I would like to express my sincere gratitude my supervisor, Engr. Dr.-Ing Azrul Azwan, my former supervisor, Dr. Omid Motlagh for all the guidance in completing this thesis. Nevertheless, to all friends of mine that never stop to give me support in moral way and also in doing this research.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

ANN	-	Artificial neural network
ANOVA	-	Analysis of Variance
CNC	-	Computer Numerical Control
DOE	-	Design of Experiment
EFA	-	Exploratory factor analysis
FCM	-	Fuzzy cognitive map
FKP	-	Fakulti Kejuruteraan Pembuatan
GLS	-	Generalized Least Squares
GRNN	-	General regression neural network
IRLS	-	Iteratively Reweighted Least Squares
MAE	-	mean absolute error
MAPE	-	Mean Absolute Percentage Error
MSE	-	Mean Square Error
OLS	-	Ordinary least-squares

PCA	-	Principal component analysis
RMSE	-	Root mean squared error
RNN	-	Recurrent neural network
RSM	-	Response Surface Method
SMC	-	Squared multiple correlations
SSE	-	sum square error
TLS	-	Total Least Squares
UTeM	-	Universiti Teknikal Malaysia Melaka
R_a	-	Determinant Coefficient
f_z	-	Feed rate
a_D	-	Axial Depth of Cut
a_R	-	Radial Depth of Cut
V_c	-	Cutting Speed

CHAPTER 1

INTRODUCTION

This section basically will view on the introduction of the thesis. A brief explanation on the background of the thesis and followed by a problem statements defined based on the theme of the research and an objectives focus of this thesis underlined by the limitation. The limitations are underlined on the designed scope for this research. A structure on the organization of this thesis research will be given briefly.

1.1 Overview of Research

Neural network provide an application that can be applied in a broad range. It is a powerful new technique for solving problems in many different disciplines. This theme of research basically will focus onto two different things. At the end of this research will give a correlation in both themes which are difference views; those areas are multivariate regression and related to neural network existing application to express a neural regression.

Linear and nonlinear regression methods are most likely used to modeling the mathematical model of regression computation. Based on several methods come up from the mathematicians, it can be presented by using this capabilities of mathematical model in the computation. This because regression refer as the problem to model a continuous dependent variables as a continuous function and can be possible to independent variables also. Therefore, classis model used to present linear and nonlinear of regression problem.

In order to relate with this research themes, neural network is a method used to develop and design for a regression problem. Hence, the main purpose of this research is to demonstrate the optimum use of artificial neural network (ANN) as a soft computation tool for determining the multivariable input and output interrelation in order determine the function for regression.

As with any modeling tool, to build a model that is effective need a lot of preparation. This preparation involves specifying the model, determining the multivariable data involved and justify the model with a sample case of an extracted data to be test. (Uys, 2010).

The concern in this context of research is often many techniques and methods that are used in these preparation to compute multivariable data. Therefore in this multivariate regression analysis using an artificial neural network, several models are proposed previous study will be view as the literature for methods used.

1.2 Problem Background

In the range of a large environment, a concern into the variables in the system which include the multivariable for the pattern recognition is to justify the correlation between multivariable influences in certain environment of a system which include dependents and independents variables. A computational classic method is often used in this situation with a precise result. The concern here is for representing a modeling to a linear or nonlinear regression problem, a statistical model especially for

nonlinear cannot be express in an explicit form as nonlinear regression model (Uys, 2010).

In addition, in the context of regression models, despite a linear or nonlinear, the main concern is about the relationship between the dependent and independent variables as mathematical function in order to define each other. In generally, as an example; of all maps the input for observation, $x_i, i = 1, \dots, p$ to an output y, defines a regression function for the maps, as this is a continuous variables (Uys, 2010).

The aim to utilize the powerful techniques of neural network can be implies here to use it excellent prediction capabilities to replace classic mathematical method. However, they are a method and techniques used in the state of preparation of statistical nature of a research system. Regression neural network are one of the several method purpose that will be discussed in details in the literature review section. Drawing a function for the interrelation nodes in a neural network for the regression problem of a system is the final state of the research analysis.

The very important part on this subject is an attempt to express neural networks in term and notation of a regression function to develop a regression neural network for a replaced mathematical model. The definition to be made on neural regression is based on the methods of linear regression. In this way, it will explain how neural networks can be fitted into a framework of a regression model. Further in this will show how the classification of neural network can be made in regression applications as according to Uys (2010).

Considering in a large environment range of system, for a specific system, involving multivariable input that influence the condition of an environmental. Imagine a linear pattern from the multivariable time series of data values for that certain system. The multivariable factors contribute to the condition of a certain environment need to be determined in this case for the interrelation of the variables in between it.